Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/268
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

LATTICE STUDIES AND CRITICAL EXPERIMENTS IN D_2O MODERATED SYSTEMS

John Crandall (E. I. du Pont de Nemours and Company - Savannah River Laboratory)
Walter L. Brooks (United Nuclear Corporation)
Irving Kaplan (Massachusetts Institute of Technology)
Francis L. Langford, Jr. (Westinghouse Electric Corporation)
Loren C. Schmid (General Electric - Hanford)

Critical and exponential experiments at Brookhaven, Hanford, Massachusetts Institute of Technology, Savannah River, and the Westinghouse Laboratories have, over the past five years, provided a very firm experimental basis to the reactor physics of uranium-D_2O systems. The major emphasis has been on buckling measurements where over 200 different lattices have been studied covering a wide range of lattice types and fuel shapes. Activation techniques have also been developed to measure such quantities as fast-to-slow-fission ratios, resonance neutron captures, conversion ratios, and neutron spectral distributions. However, the activation measurements have been applied to a smaller range of lattices than the buckling measurements. The most recent studies have been particularly concerned with the problems of heterogeneous loadings and of anisotropic effects.

The critical and exponential data have been supplemented by substitution studies both of the conventional type and of the null-reactivity variety as practiced at Hanford and United Nuclear. The substitution measurements are particularly useful in providing differentials or in making lattice surveys where only limited fuel samples are available. An interesting new addition to the substitution facilities is the Plutonium Recycle Critical Facility (PRCF) for studying irradiated fuel at Hanford. Pulsed neutron techniques in D_2O systems have found their main application in studies of D_2O itself, but are now being applied to lattices as well, particularly in the university programs at MIT, North Carolina State, and the University of Florida. A unique experimental facility is the SPERT-II reactor, which is being used for shutdown and transient studies on D_2O lattices.

Although most of the U.S. work to date has concentrated on uranium systems, limited work is now underway on plutonium and thorium systems. The plutonium-bearing lattices are being studied to provide information on plutonium buildup effects in natural uranium reactors, on plutonium recycle systems, and on plutonium irradiations to produce transuranic elements. The D_2O - thorium systems are being studied both for thorium breeder reactors and for the production of U-233.

With this wealth of experimental information at hand, many of the calculational codes are primarily recipes designed for interpolation between the experimental points. A number of calculational methods have been developed for the detailed examination of specific aspects of D_2O reactor physics. Examples are various Monte Carlo codes for studying neutron slowing-down processes and resonance capture, the THERMOS code developed by Honeck for examining thermal neutron spectral effects, and the HERESY code developed by Klahr for examining heterogeneous effects. Good results have also been obtained, particularly by Westinghouse with their CANDLE and PDQ codes, in adapting light water calculation methods to the D_2O reactors.

As the D_2O lattice data are increasingly translated into actual reactor designs, the physics information has been combined with engineering and economic information in design and cost optimization calculations, such as Savannah River's FAD code. There has also been heavy emphasis on the operational aspects of lattice design in the evaluation of control systems, of flux shaping capabilities, and of the reactor operating coefficients. A number of special codes, such as OX and LASS, have been developed to combine these data for stability studies. Most of the experimental information on operating coefficients has come from the zero-power experiments; however, significant contributions are now being obtained from the various D_2O reactors operating in the U.S. including the Savannah River production reactors, the Carolinas Virginia Test Reactor, the Heavy Water Components Test Reactor, and Plutonium Recycle Test Reactor, and the research reactors, such as CP-5 and the MITR.